(12) UK Patent Application (19) GB (11) 2 016 606 A

(21) Application No 7903234
(22) Date of filing 30 Jan 1979
(23) Claims filed 30 Jan 1979
(30) Priority data
(31) 7802610
(32) 31 Jan 1978
(33) France (FR)
(43) Application published 26 Sep 1979
(51) INT CL[2] F01D 25/12 9/00
(52) Domestic classification F1T 3A2 F1G 6
(56) Documents cited None
(58) Field of search F1G F1T

(71) Applicants
Societe National D'Etude et de Construction de Moteurs D'Aviation, 2 boulevard Victor, 75015 Paris, France

(72) Inventors
Jacques Louis Drouet
Marcel Joseph Tournere

(74) Agents
Mathisen, Macara & Co

(54) Turbine stator assembly

(57) The assembly comprises an array of shroud segments (5) surrounding the turbine rotor blades and an annular enclosure (9) surrounding the segments. Air cools the segments by impact of a multiplicity of small jets delivered from a perforate sheet (13). To avoid turbulence an annular corrugated member (17) divides the enclosure into two parts (9*a*, *b*) which receive cooling air through alternate ones of a plurality of apertures (10) in the casing (6) of the turbine, the air in one part (9*b*) flowing to the sheet (13) whereas that in the other part (9*a*) impinges on the enclosure end wall (12) before exiting through orifices (24).

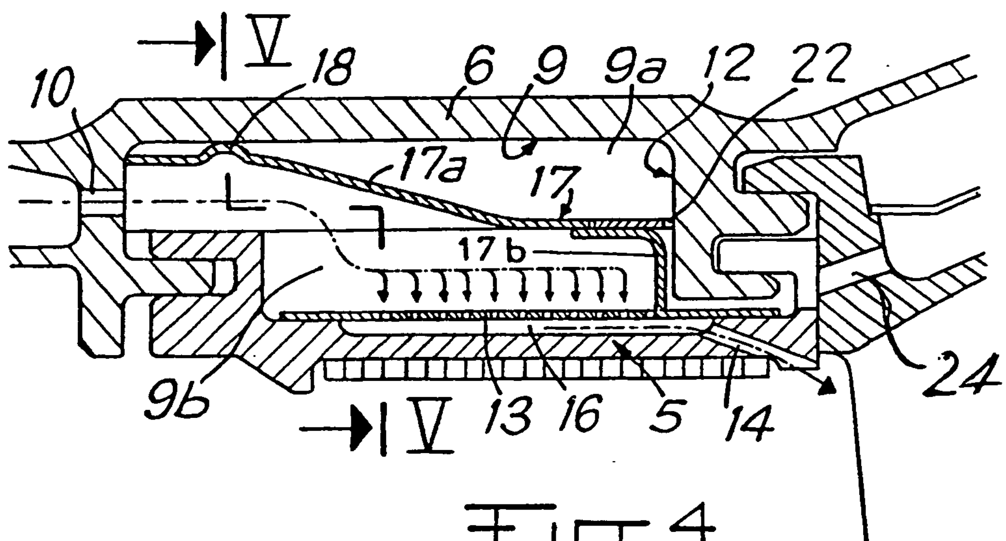


Fig 4

GB 2 016 606 A

2016606

1/4

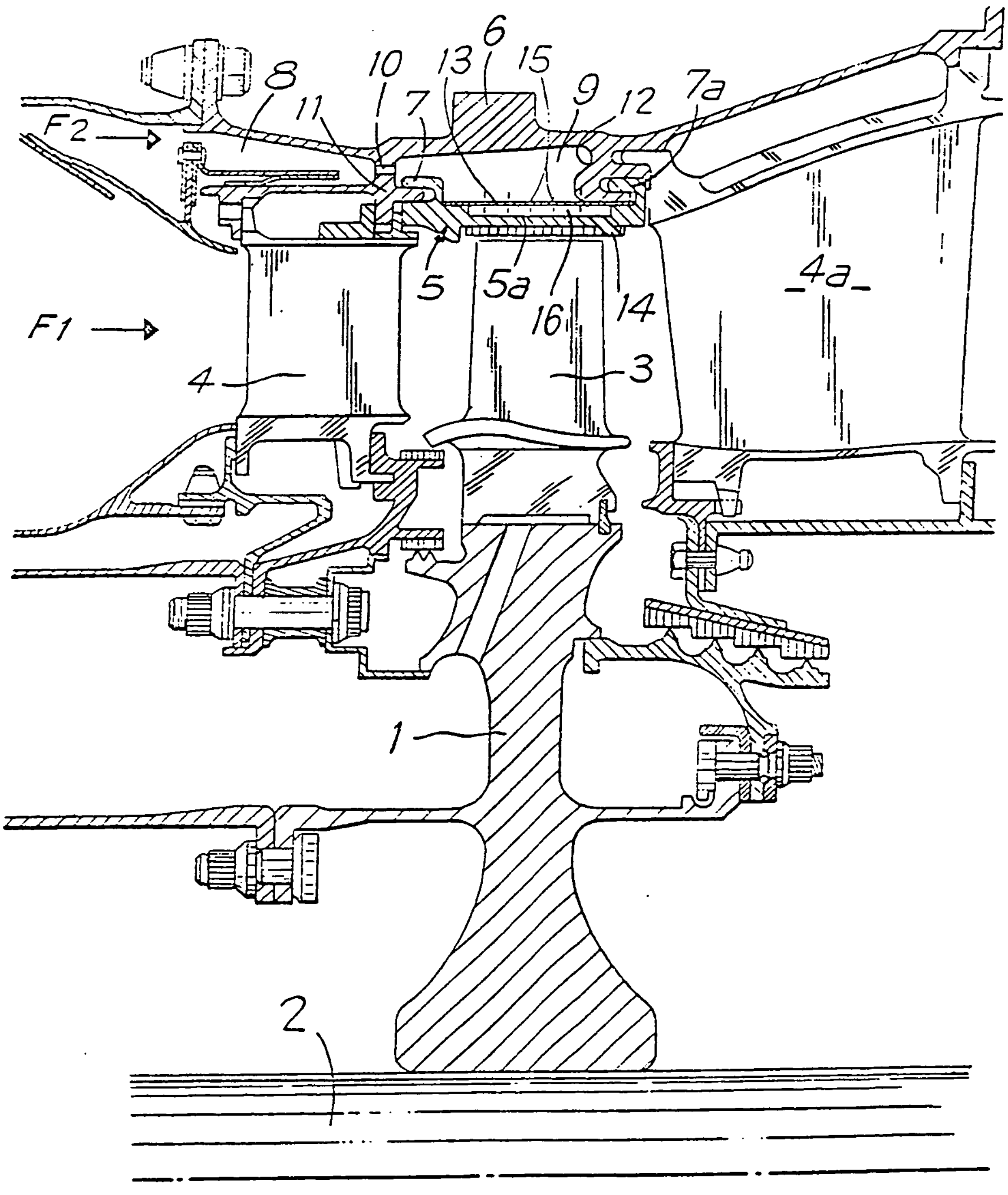


Fig-1

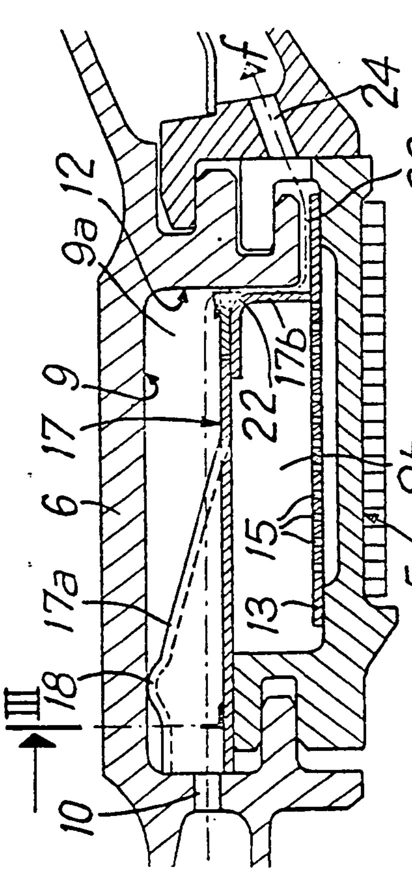


FIG. 2

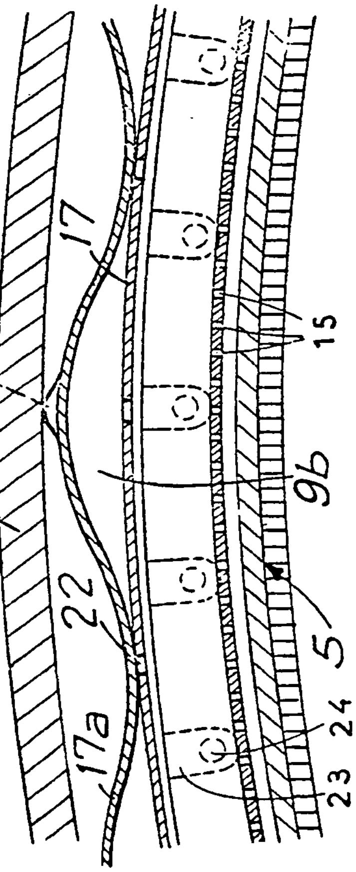


FIG. 3

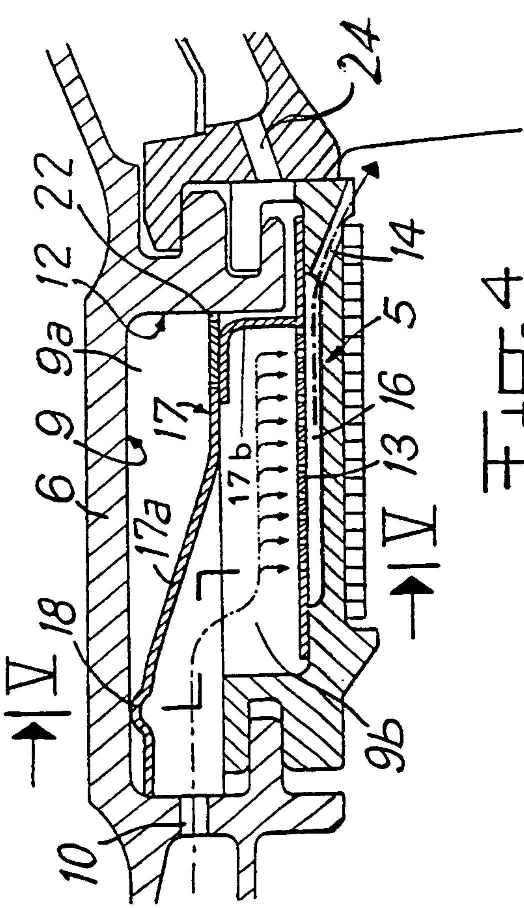


FIG. 4

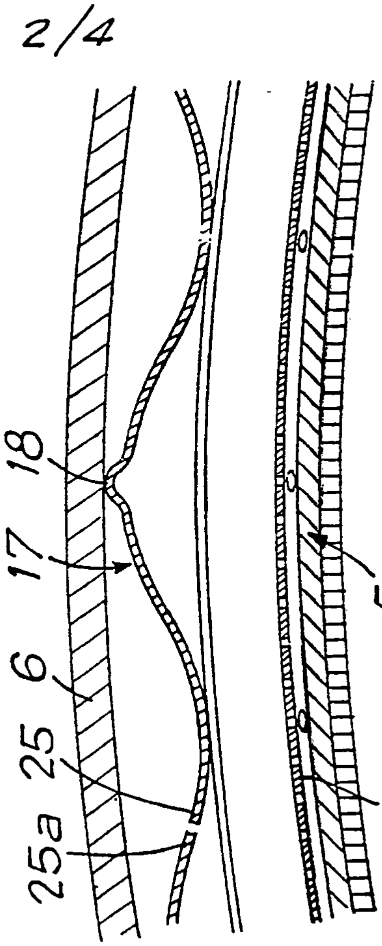


FIG. 5

POOR QUALITY

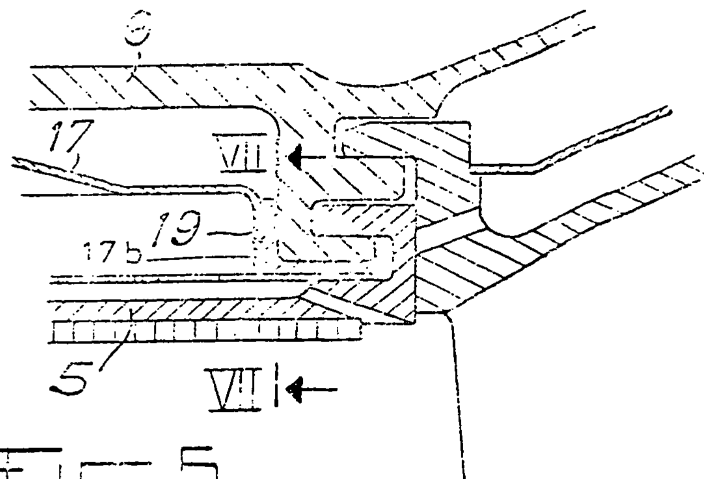


Fig. 5

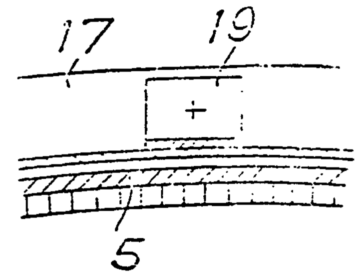


Fig. 7

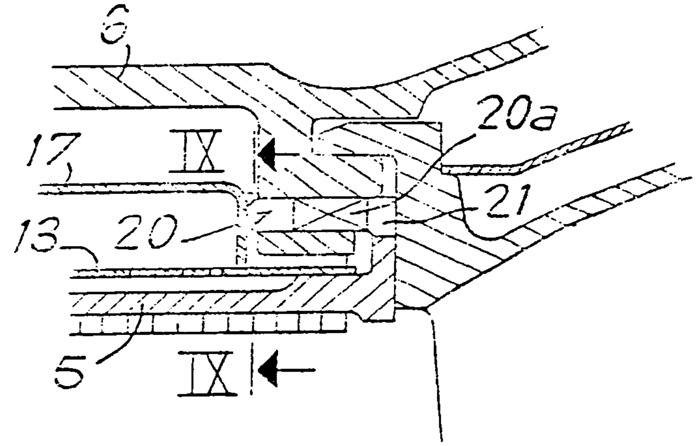


Fig. 8

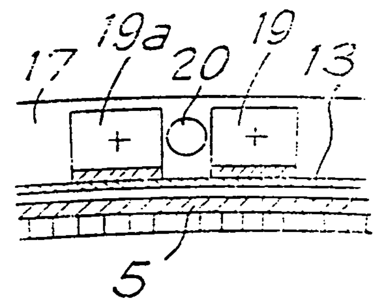


Fig. 9

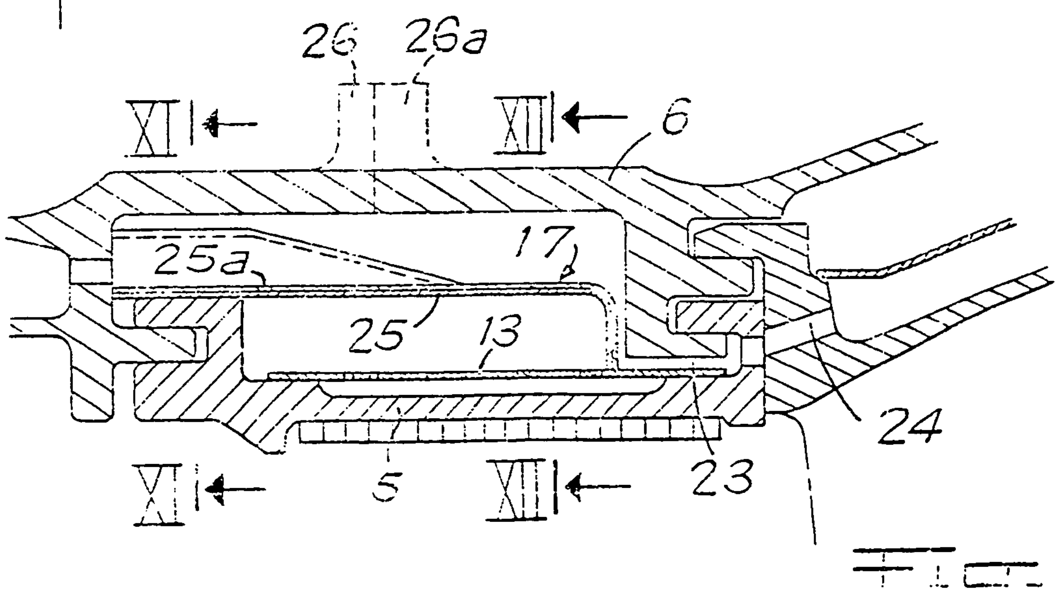


Fig. 10

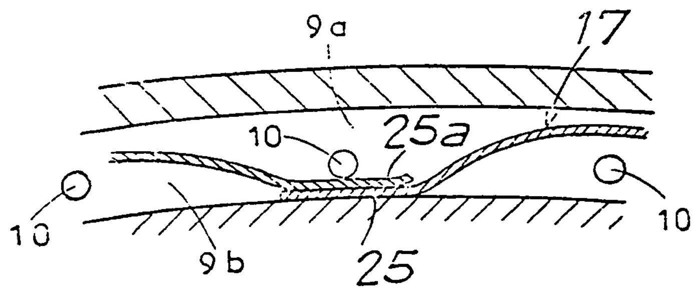
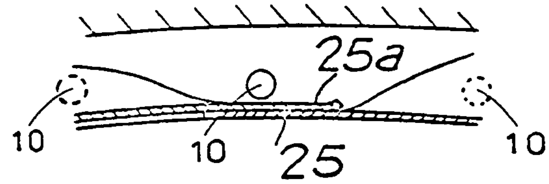


Fig. 11

Fig. 12



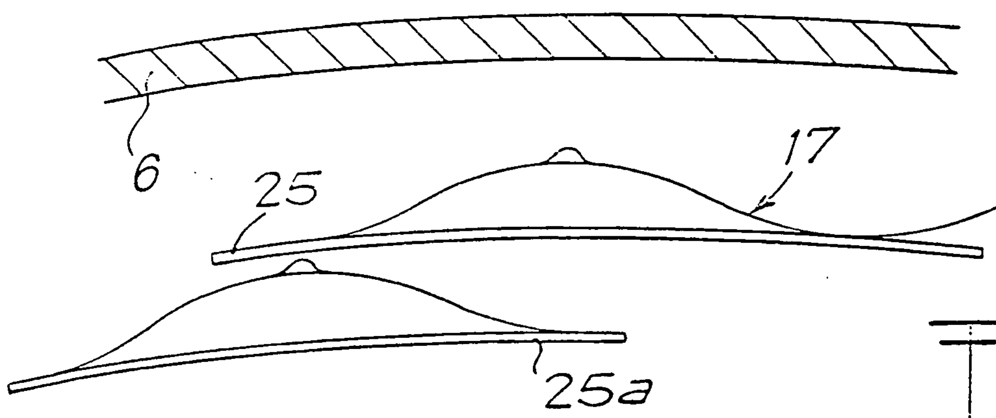


Fig. 14

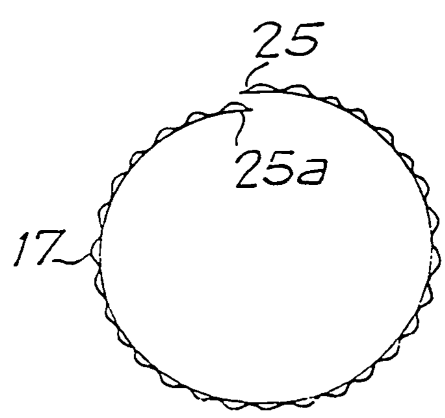


Fig. 13

SPECIFICATION

Turbine cooling arrangement

This invention relates to a turbine assembly including an impact cooling arrangement for cooling the fluid-tight segments of the turbine.

In previously proposed cooling arrangements, the fluid-tight segments of a turbine are cooled by relatively cold air bled from an upstream stage of the compressor of the engine or drawn off from the cooling air of the combustion chamber. The cooling air enters for example a concentric enclosure around the segments through regularly-distributed orifices, provided in a radial flange (or collar) of the casing of the turbine. At the exit of the orifices a part of the air impacts the walls of the casing of the turbine, another part escapes through the clearance between the casing of the turbine and the low pressure turbine nozzle and finally a last part traverses perforate thin plates which are spaced from the surface of the segments so as to cool by impact the segments before returning to the main flow of the engine.

However, turbulence which exists in the enclosure concentric with the segments, disturbs the flow of air intended for cooling of the fluid-tight segments, thus at least partially preventing the supply of the holes provided in the perforated thin plates.

According to the present invention, there is provided a turbine assembly comprising a turbine with an array of fluid-tight segments surrounding the tips of the turbine blades, means defining a cooling air enclosure located outwardly of the segments having apertures leading into the enclosure for the supply of cooling air and a passage or passages for exhausting air from the enclosure to the main working fluid path of the turbine, an annular member dividing said chamber into two chambers one of which is partially defined by a perforate member for supplying the segments with cooling air by impact and the other of which is defined by the turbine casing and the annular member itself, each said chamber being in communication with a proportion of said apertures.

Cooling arrangements embodying the invention incorporated in a gas turbine will now be described, by way of example, with reference to the accompanying diagrammatic drawings, in which:

Figure 1 is one half of an axial section of a turbine of which the fluid-tight segments are cooled by impact according to the prior art;

Figure 2 is an axial section of a part of one embodiment of a cooling arrangement for fluid-tight segments of a turbine, the plane of the section passing through the trough of a corrugation of an annular dividing member of generally circular outline;

Figure 3 is a section on line III–III of Figure 2;

Figure 4 is an axial section of the embodiment of Figure 2, the plane of the section passing through the crest of a corrugation of the annular dividing member;

Figure 5 is a section on line V-V of Figure 4;

Figure 6 is a fragm ntary axial section of a securing arrangement at the downstream end of the annular member;

Figure 7 is a section on line VII-VII of Figure 6;

Figure 8 is an axial section showing another securing arrangement which also serves for centering the annular member;

Figure 9 is a section on line IX-IX of Figure 8;

Figure 10 is a fragmentary axial section of ne segment of the turbine at the overlap of two nd portions of the annular dividing member when the latter is discontinuous;

Figure 11 is a section on line XI-XI of Figure 10;

Figure 12 is a section on line XII-XII of Figur 10;

Figure 13 is a view in section and in plan of a discontinuous embodiment of the annular member; and

Figure 14 is a view, to an enlarged scale, of a detail of the embodiment of Figure 13.

Referring first to Figure 1, the turbine of a jet-propulsion engine is shown which includes a rotor 1 coupled by a shaft 2 to a compressor (not shown), the turbine blades 3 being mounted on the rotor and being driven in rotation under the action of a hot gaseous flow, (working fluid) directed as indicated by an arrow F1 towards the blades 3 through a turbine nozzle formed by vanes 4, the shaft 2 as shown in Figure 1 also connecting a stage of the turbine disposed further downstream to a low pressure compressor upstream of the first mentioned compressor.

Adjacent to the tips of the blades fluid-tight segments are arranged in a circular array around the turbine 5 and are secured to the casing 6 of the turbine by flanges 7, 7*a*. The segments 5 are cooled by relatively cold air, delivered from an upstream stage of the compressor or bled from the cooling air of the combustion chamber (not shown) which air flows as indicated by arrow F2 in an annular-section passage 8 defined by the casing 6. This air F2 enters an enclosure 9 formed in the casing 6 around the segments 5 through regularly-distributed orifices 10 provided in a radial, inwardly-extending, flange 11 of the casing of the turbine. At the outlets of the orifices, a proportion of the cooling air strikes the walls of the far end portion 12 of the enclosure 9, forming a part of the casing 6, another portion escapes through clearances between the casing 6 and the turbine nozzle formed by the vanes 4, and finally, a remaining portion traverses perforate thin plates 13 in order to cool the segments 5 by impact before returning to the main flow of the engine through passages 14.

The thin plates 13 each have a large number of orifices 15 of small dimensions and are separated from the outer surface 5*a* of the segments by a space 16 communicating with the main flow of the engin working fluid through the passages 14.

In cooling arrangements embodying the invention as is shown in Figures 2, 3, 4 and 5, an annular dividing member 17 is located in the enclosure 9, is of generally circular form, and serves to divid the enclosure into two chambers of which one 9*a*, defined by the annular member 17 and the casing 6 of the turbine, is supplied with cooling air by a proportion of the orifices 10 and of which the other chamber 9*b* defin d by the annular member 17 and the perforate thin plates 13, is supplied by the remaining orifices 10. This division of the orifices 10

between the chambers 9a, 9b is effected by making the annular member 17 of corrugated form 17a at least at its upstream part, the pitch of the corrugations being selected so as to provide communication by one half of the orifices 10 (Figures 2, 4, 11 and 12) to the chamber 9a, and the other half of the orifices 10 to the chamber 9b.

The distribution of the cooling air, between the chambers 9a and 9b can be modified by imparting to the corrugations of the corrugated part 17a a different shape or pitch, so as to circumscribe in each corrugation located particularly on the side of the chamber 98 more than one orifice 10. It is thus possible to supply twice the air flow to the perforate thin plates 13 than that provided in the chamber 9a.

The annular member 17 thus ensures a better cooling air supply to the impact orifices 15, whilst preserving the beneficial action of cooling due to impact on the far end portion 12 of the enclosure 9.

The cooling air derived from the chamber 9b traverses the plates 13 through the orifice 15, strikes the wall of the fluid-tight segments from a substantially radial direction and escapes from the space 16 through the passages 14 (Figure 4).

The air striking the far end portion 12 of the chamber 9a is exhausted along a path indicated by the arrow f. It is therefore necessary to leave a space between the downstream part of the annular member of generally circular form located in a radial plane, and the far end portion 12 of the enclosure 9 (Figures 6 and 10). To this end, the annular member includes an annular part 17b disposed in a radial plane, at its downstream end, this annular part may be made separately in accordance with the embodiments of Figures 2 and 4, or made integrally by stamping as is illustrated in the Figures 6 or 8. A space is formed between the part 17b and the far end portion 12 of the casing, which enables the evacuation of the air which has entered the chamber 9a to the orifices 24 through crenellations, castellations, or holes 23 formed in the fluid-tight segments 5.

It is advantageous in certain cases, so to shape the corrugations of the annular member 17 that they act as a diffuser for the air entering through the orifices 10 into the chamber 9a, in order to reduce the kinetic energy of the jets on impact with the far end portion 12 of the enclosure 9, and to ensure more homogeneous cooling.

The annular member 17 is made of a material having good elongation properties particularly a thin sheet steel, capable of being deformed, so as to form the annular member in the shape of a continuous annulus (Figures 2 and 3) of which the mounting is ffected by deformation in order to engage tightly in the enclosure 9 of the casing, before location of the fluid-tight segments 5.

Because of this facility of deformation, the annular member is held at the upstream end within the casing by engagement between the casing and the segments 5, projections 18 being provided at the crests of the corrugations which are in firm frictional contact with the casing.

At the downstream end, the annular member 17 is held by angle section members 19 secured by known means to the annular member and held engaged between the casing 6 and the segments 5 (Figures 6 and 7).

The centering and the securing f the annular member in the enclosure 9 may be ffected through the intermediary of centering pieces 20 of the segments (Figures 8 and 9).

These pieces 20 are formed from a parallelopiped part 20a which cooperates with the crenellations 21 formed on a flange of each segment 5 and a cylindrical part engaging between two angle members 19, 19a secured on the annular member, as has been mentioned hereinbefore.

The mounting of the annular section member 17 may, in certain cases, be simplified by cutting it and then has the form of a member of rolled strip (Figures 13, 14) having two end portions 25, 25a which are disposed edge to edge as in the embodiment of Figure 5 is order to ensure fluid-tightness.

In another embodiment as shown in Figures 10, 11 and 12, the two end portions 25, 25a of the strip member constituting the annular section member 17 are connected by overlapping so as to ensure fluid-tightness between the two chambers 9a, 9b. It is also possible to form the annular member 17 from a plurality of segments.

According to a modification shown in broken lines in Figure 10, it is also possible to facilitate the mounting of the annular member 17 to divide the casing 6 into two members which are assembled together by means of supplementary flanges 26, 26a.

CLAIMS

1. A turbine assembly comprising a turbine with an array of fluid-tight segments surrounding the tips of the turbine blades, means defining a cooling air enclosure located outwardly of the segments having apertures leading into the enclosure for the supply of cooling air and a passage or passages for exhausting air from the enclosure to the main working fluid path of the turbine, an annular member dividing said chamber into two chambers one of which is partially defined by a perforate member for supplying the segments with cooling air by impact and the other of which is defined by the turbine casing and the annular member itself, each said chamber being in communication with a proportion of said apertures.

2. An assembly according to claim 1, wherein the annular member has a generally circular outline and has an upstream portion of corrugated form so arranged that the air supply apertures dischage into the two chambers and thereby the air supply is divided between the two chambers in required proportions.

3. An assembly according to claim 1 or claim 2, wherein the passage for the exhaust of the cooling air is disposed between the downstream end of the annular member and a portion of the casing lying opposite the air supply apertures, the passage lying substantially in a radial plane.

4. An assembly according to any one of claims 1 to 3, wherein the annular member is engaged at the upstr am end portion between the turbine casing and th fluid-tight segments.

5. An assembly according to claim 4, wherein projections are provided on the upstream end portion of the annular member which act t provide firm

contact with the turbine casing.

6. An assembly according to any one of the preceding claims, wherein the annular member is secured at its downstream end by means of angle-section members engaged against the turbine casing and the fluid-tight segments.

7. An assembly according to any one of the preceding claims, wherein the centering and securing against rotation of the annular member within the enclosure are effected by means of centering pieces of the fluid-tight segments.

8. An assembly according to claim 7, wherein the centering pieces have a part of parallelopiped form which is engaged in a castellation of a flange of each fluid-tight segment and a cylindrical part engaged between two said angle-section members.

9. An assembly according to any one of claims 2 to 8, wherein the corrugated portion of the annular member is shaped as a diffuser acting on the cooling air.

10. An assembly according to any one of the preceding claims, wherein the annular member is a continuous member of high elongation material, the mounting of the member being effected in the enclosure by deformation of the member.

11. An assembly according to any one of claims 1 to 9, wherein the annular member is constituted by a rolled member or strip of which end portions are in overlapping relationship.

12. An assembly according to any one of claims 1 to 9, wherein the annular member is discontinuous and the ends are arranged to abut one another.

13. An assembly according to any one of the preceding claims, wherein the turbine casing is formed in two parts assembled together with the aid of flanges.

14. A turbine assembly substantially as hereinbefore described with reference to the accompanying drawings.

Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd., Berwick-upon-Tweed, 1979.
Published at the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.